SUMMARIES OF PRE-CAMBRIAN LITERATURE OF NORTH AMERICA

EDWARD STEIDTMANN
University of Wisconsin

II. ONTARIO

In the region northeast of Lake Huron, the pre-Cambrian rocks according to Collins and others show one conspicuous unconformity. The rocks beneath this unconformity comprise a series of quartzites and other clastic sediments, the Timiskaming series, etc., intruded by granitic rocks. Unconformably beneath these sediments is an older series, the Keewatin, including basic flows, some acid extrusives, iron formations, dolomites, etc. The Keewatin is intruded by the Laurentian granites and gneisses.

Above the conspicuous unconformity are two series of slightly metamorphosed dominantly clastic sediments separated by an inconspicuous unconformity. The lower one, the Bruce series, locally contains tillites. The upper series is generally known as the Cobalt series. At Killarney on the north shore of Lake Huron, Collins has found that the Bruce and possibly the Cobalt series are intruded by the Killarney granite and in this locality they assume many of the characteristics of the older series, the Timiskaming. The youngest pre-Cambrian rocks are Keweenawan, basic dikes and sills.

Northwest of Lake Superior, Lawson has restudied the Rainy Lake and Steeprock Lake districts. Greenstones and other rocks typical of the Keewatin are widely exposed in this region. Beneath them are acid schists called Coutchiching by Lawson. Unconformably above the Keewatin in the vicinity of Rainy Lake are a series of conglomerates and slates called the Seine series by Lawson. In the Steeprock Lake district, the Steeprock Lake series lies unconformably between the Keewatin and Seine series. The Steeprock Lake series, besides clastic sediments, comprises fossil-bearing dolomites.

The youngest rocks of the region are basic dikes classed as Keweenawan.

Baker[1] classifies the pre-Cambrian rocks of the Kingston area in southeastern Ontario as follows:

Great unconformity
Keweenawan—Trap, diabase, and gabbro intrusives
Intrusive contact
Algoman—Coarse-grained granite and syenite intrusives with later pegmatites
Intrusive contact
Laurentian—Gray to pink, medium to fine-grained, granitic gneisses
Intrusive contact
Grenville—White, coarsely crystalline limestone with quartzite and rusty weathering gneisses.
Dark green to black gneisses—thoroughly impregnated with minute dikes of Laurentian granite, now also changed to gneiss.

As reported by E. L. Bruce,[2] the succession in the Cripple Creek Gold district located about twenty-five miles southwest of Porcupine, Ontario, is:

Glacial and Recent
Peat, unsorted and more or less sorted sands and clays
Unconformity
Post-Laurentian
Diabase dikes
Igneous contact
Laurentian
Gray granite—reddish gneissoid granite
Igneous contact
Keewatin
Greenstones, schists, diabase, and iron formation

The Kirkland Lake and Swastika[3] gold areas are located in the Timiskaming district, fifty miles north of Cobalt. The pre-Cambrian rocks are classified as follows:

Later dikes—Diabase
Intrusive contact

[1] M. B. Baker, "The Geology of Kingston (Ontario) and Vicinity," *Ontario Bur. Mines, 25th Ann. Rept.*, Vol. XXV, Part 3 (1916), pp. 1–36, 19 figs., map.

[2] E. L. Bruce, geologist, and W. R. Rogers, topographer, "Cripple Creek Gold Area, *Ontario Bur. Mines*, Vol. XXI (1912), Part I, pp. 256–65, 9 figs.

[3] A. G. Burrows and P. E. Hopkins, "The Kirkland Lake and Swastika Gold Areas, *Ontario Bur. Mines, 23d Ann. Rept.*, Vol. XXIII, Part II (1914), pp. 1–39.

Cobalt series—Nearly flat-lying conglomerate with bowlders of granite and syenite

Unconformity

Post Timiskaming intrusives—Granite, syenite, feldspar, porphyry, lamprophyre

Intrusive contact

Timiskaming series—Quartzite, graywacke, conglomerate with schistose derivatives. The conglomerates contain a variety of pebbles derived from the Keewatin

Keewatin—Greenstone (basalt andesite) diabase, quartz porphyry, feldspar porphyry, iron formation, dolomite

Burrows[1] maps the Matachewan Gold area on Montreal River in latitude 48. Below is the table of formations:

Animikean-Cobalt series—Conglomerate, quartzite, graywacke, slate

Unconformity

Algoman—Granite, syenite, and thin acid intrusives

Intrusive contact

Laurentian—Granite and gneiss

Keewatin—Greenstones, iron formation, some quartzite, conglomerate, etc.

Burrows[2] classifies the pre-Cambrian rocks of the Porcupine Gold area of Ontario as follows:

Keweenawan—Quartz diabase, olivine diabase

Intrusive contact

Algoman—Granite porphyry, feldspar porphyry

Intrusive contact

Pre-Algoman—Lamprophyre, serpentine quartz porphyry

Intrusive contact

Timiskaming series—A series of schistose conglomerates, interbanded slate and graywacke, quartzite "carbonate" rock

Unconformity

Keewatin—A couple of largely schistose basic to acid volcanics, agglomerates, ash rocks, iron formation, rusty weathering, "carbonate," diabase, serpentine, etc.

The gold occurs in quartz veins cutting the Keewatin and Timiskaming series and the pre-Keweenawan intrusives. They are believed to be related genetically to the Algoman intrusives.

[1] A. G. Burrows, "The Matachewan Gold Area," *Ontario Bur. Mines, Ann. Rept.*, Vol. XXVII (1918), Part I, pp. 215–40, maps and illustrations.

[2] A. G. Burrows and P. E. Hopkins, "The Porcupine Gold Area" (Third Report), *Ontario Bur. Mines, Ann. Rept.*, Vol. XXIV, Part III (1915), pp. 1–57, 44 figs. inclusive, maps; see also *ibid.* (Second Report), *Ontario Bur. Mines 21st Ann. Rept.*, Vol. XXI (1912), pp. 205–49, 37 figs.

The Whiskey Lake[1] area includes two unsubdivided townships, Nos. 137 and 138, in the third and fourth tier of townships north of Lake Huron. The pre-Cambrian rocks of the area are provisionally classified as:

Middle Huronian—Conglomerate and quartzite
Unconformity
Lower Huronian—Conglomerate, quartzite, slate, and limestone
Great unconformity
Sudbury series—Slate and probably quartzite, part of the greenstone
Unconformity
Keewatin—Most of the greenstone and green schist
Laurentian—Granite and syenite

Coleman[2] classifies the pre-Cambrian succession along the north shore of Lake Huron as follows:

Keweenawan—Basic volcanic eruptives and basic sills. Subordinate coarse, usually red sediments, probably indicating warm, dry climate
Animikie—Black slates, volcanic tuff, bowlder conglomerate
Huronian—Arkose and quartzite, shallow lake or sea deposits indicating cool climate. Bowlder conglomerate or tillite formed under glacial conditions
Sudburian—Pillow basic lava flows. Coarse sediments—conglomerates, bowlder beds, arkoses, quartzites derived mainly from the disintegration of granites
Grenville—Quartzites, schist, and impure calcareous sediments whose relation to the Keewatin is uncertain. Intrusion of granites
Keewatin—Basic eruptions and jaspititic iron formations

Coleman[3] classifies the pre-Cambrian rocks of the region north of Lake Huron extending from Point Mamainse to Wanapitie as follows:

Post-Laurentian
- Keweenawan
- Discordance
- Animikie
- Discordance
- Upper Huronian

Great discordance

Pre-Laurentian
- Sudbury series
- Great discordance
- Keewatin—Probably equal to the Grenville series

[1] A. P. Coleman, "The Whiskey Lake Area," *Ontario Bur. Mines, 22d Ann. Rept.*, Vol. XXII (1913), Part I, pp. 146–54, 5 figs.

[2] A. P. Coleman, "The Pre-Cambrian Rocks North of Lake Huron with Special Reference to the Sudbury Series," *Ontario Bur. Mines, Ann. Rept.*, Vol. XXIII (1914), Part I, pp. 204–36, map, 18 figs.

[3] A. P. Coleman, "The Sudbury Series and Its Bearing on Pre-Cambrian Classification," *Congrès Géologique International XII.* Session 1914.

The major divisions are based on the position of the various series with reference to a conspicuous unconformity and to certain granite batholiths. He recommends that this section be adopted as a standard for the Lake Superior region.

In 1915 Coleman[1] classified the rocks of the Canadian Shield to the northeast of Lake Huron as follows:

Late Proterozoic	Keweenawan (Mamainse and nickel eruptive)	
	Discordance	
	Upper Huronian	Typical Huronian
	Small discordance	Typical Huronian
	Lower Huronian	Typical Huronian
	Great discordance	
Early Proterozoic	(Laurentian granite and gneiss)	
	Eruptive contact	
	Sudburian—Timiskaming, Pontiac, etc.	
	Great discordance	
Archaeozoic	(Granite eruptive through lower series)	
	Eruptive contact	
	Keewatin and Grenville	

The important points of this classification are the recognition of two major unconformities in the succession and the naming of certain granites and gneisses which are intrusive into rocks younger than the Keewatin, as Laurentian. In his discussion following the classification, he substitutes the term Animikie for Upper Huronian. The term Sudburian for a series is recent in the general discussions of the stratigraphy of the Canadian Shield. This series, Coleman states, is typically developed in the Sudbury district, where it consists chiefly of quartzites, slates, and conglomerates, without limestones or dolomites, and with almost no carbon. These rocks are severely folded, but not intensely altered excepting near intrusives. Their deposition was followed by the extrusion of lava Sudburite, the effusive equivalent of Norite. Other probably Sudburian areas include portions of the region to the northeast of the Wahnapitae River, and the Timiskaming, Gowganda, Larder Lake districts, the area of the Pontiac series of Quebec, the Doré formation of the east shore of Lake Superior, and certain rocks of Heron Bay on the north shore of Lake Superior,

[1] A. P. Coleman, "The Proterozoic of the Canadian Shield and Its Problems," *Problems of American Geology* (1915), pp. 81–161.

the Nipigon area, the Onaman Iron Range, and the Seine River in the Rainy Lake district. The Sudbury series he regards as being partly a delta deposit laid down in a moist cool climate, but finds it strange that carbon is lacking. In the interval between Sudburian and Huronian time, the area was folded and eroded to a surface very much like that of the present Canadian Shield.

For the nature of the Lower Huronian, he refers to Logan's type section on the northeast coast of Lake Huron. Tillites are a characteristic constituent of the Huronian, but in addition it contains stratified deposits. Other Lower Huronian areas are found in the Larder Lake, Chibougama, and Steep Rock Lake districts. The Lower Huronian rocks have a marked unconformity at their base, but are in general less severely folded than the Sudbury series. At the start the climate of the period appears to have been cool and glacial. The existence of animals is suggested by the occurrence of limestone.

The Animikie he characterizes as a period of great submergence during which great quantities of iron compounds and black slates were deposited.

The Keweenawan of the Canadian Shield rests upon the eroded Animikie. It includes three series, of which the two lower are chiefly sedimentary, while the upper is largely volcanic. The sediments consist largely of sandstones and conglomerates, characterized by red color and absence of carbon. The volcanics are chiefly basic flows, but possibly include some felsites and porphyries. Dikes are common, but as yet no definite volcanic vents have been found. Other areas of the Canadian Shield probably containing Keweenawan are the Nastapoka and Manitaunick Islands, Central Labrador, and the south side of Hudson Straits, the regions of Lake Athabasca, Great Slave Lake, and the area between the east side of Great Bear Lake along the Copper Mine River northward to the Arctic Ocean. Deposition during Keweenawan time, according to Coleman, was chiefly on the land in a warm dry climate. He speculates as to the source of great quantities of lavas and relates the development of the Lake Nipigon, Sudbury, and Lake Superior basins to the collapse of the surface resulting from the extrusion of the lavas.

The base of the succession exposed in the Gowganda[1] district consists of Keewatin greenstones mostly of igneous origin associated with some iron formation. They are intruded by batholiths of Laurentian granite. Overlying the granites and greenstones with well-marked unconformity are Huronian sediments which are separated into two members by a faint unconformity. The lower group from 500 to 1,000 feet thick consists of conglomerates, arkose, graywacke, and slates, showing poor assortment, variable bedding, and till-like character in the coarse phases. Locally, the beds are associated with rhyolitic extrusions. The upper is a single quartzite formation 600 or more feet thick, ranging from arkose to pure, well-bedded quartzite.

Intruded into the preceding are Keweenawan diabase sills and dikes.

Selected areas between the original Huronian and the Cobalt and Sudbury districts were examined by Collins[2] with the view of correlation. The Bruce, Blind River, Whiskey Lake, Española, and Round Lake areas were selected, the widest gap between them being about 28 miles.

Collins recognizes two major stratigraphic divisions, the pre-Huronian and the Huronian. They are separated by the most conspicuous unconformity of the region, characterized by a strong basal conglomerate, great differences in structure, metamorphism, igneous intrusions, and general lithologic character of the two groups. The pre-Huronian consists of basic schists and gneisses mostly of igneous origin, granite batholiths of more than one period of intrusion and highly metamorphosed slates and quartzites. The pre-Huronian has not been completely subdivided into stratigraphic units and its various members have not been traced and correlated over the entire region.

The Huronian is separated into two units by an unconformity far less pronounced than the one at the base of the Huronian. Individual beds of both divisions have been traced successfully from district to district. The lower division, called the Bruce

[1] W. H. Collins, "The Geology of Gowganda Mining Division," *Canada Geol. Surv. Mem. No. 33* (1913), 121 pp., 4 pls., 5 figs.

[2] W. H. Collins, "The Huronian Formations of Timiskaming Region, Canada," *Canada Geol. Surv. Mus. Bull. No. 8* (1914), 27 pp., 2 maps, 1 fig., 1 pl.

series, consists of a thin basal conglomerate, white quartzites with interbedded, well-sorted conglomerates, an impure siliceous limestone, and some graywacke, whose maximum thickness is more than three thousand feet. The upper division, or Cobalt series, includes tillites, quartzites, graywackes, a few thin impure limestone beds and grades upward into pure quartzites. It has in part the characteristics of glacial till associated with stream and quiet-water deposits contemporaneous with glaciation. Locally it shows minor unconformities. The local terms, Bruce and Cobalt series, rather than Lower Huronian and Upper Huronian, are applied to these divisions because their full equivalence to these units in the original Huronian is regarded as doubtful.

Collins[1] advocates that a local classification of the pre-Cambrian rocks of the Timiskaming region be adopted and that their correlation with other districts be postponed until they are better known. He emphasizes the importance of the unconformity at the base of the Cobalt series as major plane of division. The various series are classified by him as pre-Huronian and Huronian. His classification follows:

Keweenawan	Diabase	
	Sudbury norite	
	Intrusive contact	
	Whitewater series	Huronian
	Lorrain series	
	Local unconformity	
	Cobalt series	
	Great unconformity	
	Batholithic granite intrusive	
	Intrusive contact	
	Sudbury, Timiskaming, Fabre series	Pre-Huronian
	Unconformity	
	Granite intrusives	
	Keewatin group	

Collins[2] reports that hitherto unknown granites intrude the Bruce and probably the Cobalt series along the coast of Lake Huron.

[1] W. H. Collins, "A Classification of the Pre-Cambrian Formations in the Region East of Lake Superior," *Congrès Géologique International XII.* Session 1914, pp. 399–407.

[2] W. H. Collins, "The Age of the Killarney Granite (Ontario)," *Canada Geol. Surv. Mus. Bull. No. 22* (1916), 12 pp., 1 pl., 1 fig.

Collins[1] reports on the Onaping map area about fifty miles north of Sudbury. Following his former practice, he divides the pre-Cambrian rocks into Huronian and pre-Huronian. His table of pre-Cambrian formations follows:

Huronian—Keweenawan — Olivine diabase
Basic intrusives? — Quartz diabase
Quartz norite and intermediate varieties
Intrusive contact
Cobalt series—Upper white quartzite
Banded cherty quartzite
Lorrain quartzite
Gowganda formation:
Conglomerate
Graywacke
Limestone
Great unconformity
Pre-Huronian
Batholithic intrusives—Granite gneiss and its differentiates
Schist complex—Altered volcanic and intrusive rocks, iron formation, and other sediments

P. E. Hopkins[2] reports the succession in McArthur township of the Porcupine Gold Area as

Late intrusives—Diabase
Timiskaming?—Slates
Laurentian—Granites intrusive into Keewatin
Keewatin—Greenstone, serpentine, hornblende schists, porphyries, carbonates, and chert magnetite iron formation

Hopkins[3] reports on the Beatty-Munro Gold area in the Larder Lake mining division of Ontario, latitude 48° 30′, longitude 80° 15′. The rocks are all pre-Cambrian and are classified by Hopkins as follows:

Post-Timiskaming intrusives—Feldspar porphyry dikes
Intrusive contact
Diabase dikes and stocklike masses
Intrusive contact

[1] W. H. Collins, "Onaping Map Area (Ontario)," *Canada Geol. Surv. Mem., No. 95* (1917), 157 pp., 11 pls., 8 figs., 2 maps.

[2] P. E. Hopkins, "Notes on McArthur Township," *Ontario Bur. Mines, 21st Ann. Rept.*, Vol. XXI (1912), Part I, pp. 278–80, 2 figs.

[3] P. E. Hopkins, "The Beatty-Munro Gold Area (Ontario)," *Ontario Bur. Mines, Ann. Rept.*, Vol. XXIV (1915), Part I, pp. 171–84, 9 figs., 1 map.

Timiskaming series—slate, graywacke, quartzite conglomerate, and schistose derivatives

Igneous—Feldspar porphyry—relation to Timiskaming uncertain—intrudes Keewatin

Intrusive contact

Keewatin—Amygdaloidal and ellipsoidal basalt, diabase, serpentine, iron formation, and breccia, with metamorphosed equivalents

The gold occurs as free gold and as tellurides in quartz veins cutting Keewatin and Timiskaming rocks. The veins contain high-temperature minerals, viz., pyrrhotite and tourmaline.

Kindle and Burling[1] conclude that the escarpment of pre-Cambrian rocks which overlooks the plain of Paleozoic sediments north of the Ottawa and St. Lawrence rivers is due to normal faulting, the sediments being on the downthrow side. The facts which indicate this are: (*a*) the presence of Paleozoic outliers resting on a hummocky surface of pre-Cambrian rock north of the escarpment, the corresponding Paleozoic beds south of the escarpment being about seven hundred feet lower, (*b*) the extreme regularity of the escarpment, (*c*) the absence of Paleozoic re-entrants along the escarpment, (*d*) the lack of clastic material from the limestone adjacent to the pre-Cambrian rocks of the escarpment, (*e*) the dissimilarity of the escarpment features with other nearby pre-Cambrian borders where normal erosion has even yielded an escarpment of Paleozoic rocks, (*f*) the escarpment is at the northern border of a zone in which subsidence or normal faulting is characteristic.

Knight[2] finds the following succession of pre-Cambrian rocks in the Thessalon area on the north shore of Lake Huron to the west of Killarney. This is the original Huronian area of Logan.

Diabase dikes intersecting Nipissing

Keweenawan—Diabase

Intrusive contact

Nipissing diabase, similar to that at Cobalt and Gowganda—shows local gradations into pink micro pegmatite. Thessalon greenstone, a fine-grained basal sometimes amygdaloidal

Intrusive contact

[1] E. M. Kindle and L. D. Burling, "Structural Relations of the Pre-Cambrian and Paleozoic Rocks North of the Ottawa and St. Lawrence Valleys," *Canada Geol. Surv. Mus. Bull. No. 18* (1915), 23 pp., 2 pls., 6 figs.

[2] C. W. Knight, "The North Shore of Lake Huron," *Ontario Bur. Mines, Ann. Rept.*, Vol. XXIV (1915), Part I, pp. 216–41, 13 figs.

Animikean—1. Pink quartzite and arkose with thin beds of jasper conglomerate similar to Lorrain series at Cobalt
2. Slatelike graywacke—beautifully and thinly bedded
3. Conglomerate, graywacke, slatelike graywacke, quartzite, arkose

Great unconformity

Algoman—Granite, massive, and at times gneissoid

Knight[1] and others report on the Abitibi-Night Hawk Gold Area southeast of Cochrane on the Canadian National Railway. The succession includes Keewatin rocks consisting of basic pillow lavas, rhyolites, basalt, diabase, hornblende, and chlorite schists, which are overlain by slate graywacke, quartzite, conglomerate, and iron formation. These Keewatin rocks are intruded by diabase and gabbro, peridotite and pyroxenite, granite and other acid rocks, quartz diabase and olivine diabase dikes.

In 1911[2] A. C. Lawson restudied the Rainy Lake area which he had reported on in 1887. In 1887, Lawson reported that the pre-Cambrian rocks of this region were all Archean and that the succession from the bottom upward is as follows:

A series of clastic sediments metamorphosed to mica quartz schists and paragneisses called the Coutchiching. This series is conformably overlain by the Keewatin, consisting dominantly of amygdaloidal and ellipsodial greenstone lava flows, chloritic schists, and other basic rocks of a similar nature. The Coutchiching and Keewatin were intruded by batholithic masses of granite and granite gneisses and allied acid igneous rocks which caused the doming up of the rock into which they were injected.

The restudy of the Rainy Lake area by Lawson in 1911 was occasioned by the fact that the United States Geological Survey and the International Committee of 1898 did not accept Lawson's conclusion that there existed a Coutchiching series of rocks stratigraphically below the Keewatin. This dissent from the opinion of Lawson was based on field work by Van Hise in various parts

[1] C. W. Knight, A. G. Burrows, P. E. Hopkins, and A. L. Parsons, "Abitibi-Night Hawk Gold Area," *Ontario Bur. Mines, 28th Ann. Rept.* (1919), 84 pp., maps, and illustrations.

[2] "The Archean Geology of Rainy Lake," restudied by A. C. Lawson. *Canada Geol. Surv. Mem. No. 40* (1913), 111 pp., geological map in pocket, 9 pls., 1 fig.

of the Rainy Lake area, and in consequence of the examination of the Coutchiching series on the east end of Shoal Lake and along parts of the Seine River by the International Committee of 1898. The International Committee found that the so-called Coutchiching of Lawson on the east end of Shoal Lake consisted of conglomerates and other clastic sediments which unconformably overlie the Keewatin. They then concluded that all of the rocks mapped by Lawson as Coutchiching are not below the Keewatin.

In consequence of Lawson's restudy of 1911, he persists in classifying the rocks of the Rainy Lake area as Archean. He holds to this classification because he regards it as historically correct, having been, he claims, the usage of Logan in his map of the north shore of Lake Huron, and furthermore, he believes that the erosion interval which intervenes between the rocks of the Animikie series and those which precede it is the most conspicuous in the pre-Cambrian rocks of the Lake Superior region. He believes that the rocks on the far side of this erosion interval show greater metamorphism and more intense folding and a larger number of intrusions than those on the near side of this interval.

On re-examining the Coutchiching rocks on the east side of Shoal Lake, he finds that the conclusions of the International Committee are correct for this particular locality. He finds no evidence, however, to change his original conclusion regarding the Coutchiching which is wrapped around domes of intrusive granite and which dips under the Keewatin at a low angle in the region of Rice Bay and around Bear's Passage. Lawson's classification of the rocks of the Rainy Lake district follows.

Keweenawan—Diabase dikes

Algoman { Granite, porphyritic, and syenite gneisses, and a basic facies of syenite

Huronian (Seine series) { Lamprophyric rocks; Quartzite and slate, and schists; Conglomerate

Laurentian—Granite and granite gneiss

Archean Keewatin { Anorthite; Hornblende gabbro; Limestone (one seam); Greenstone, greenstone schists, felsite, sericite schist, ash beds, agglomerate, siliceous slates and schists, chert, mica schist

Coutchiching mica schist, paragneiss, and phyllite

Lawson[1] classifies the pre-Cambrian rocks of Steeprock Lake, Ontario, as follows:

Algonkian
- Keweenawan
  - Erosion interval
- Animikie
  - Eparchean interval

Archean
- Granite gneiss, intrusive in the Seine series
  - Irruptive contact
- Seine series
  - Acute deformation and erosion interval
- Steeprock series
  - Erosion interval
- Granite gneiss, intrusive in the Keewatin
  - Irruptive contact
- Keewatin
- Coutchiching

The Steeprock series comprise interbedded sediments and irruptive rocks: dark-gray slate, agglomerate, greenstones and green schists, conglomerates, and limestone. Van Hise and Leith have correlated them as Lower Huronian.

Lawson describes certain radial calcareous and siliceous fossil structures of the limestones. The rays of these fossils extend to a roughly circular limit in section normal to the axis of the organism. In oblique sections, the border is usually elliptical. In some cases, they are cornucopia-shaped, the rays sometimes showing conical or elliptical septa. The rays vary from one to fifteen inches in length.

The paper is supplemented by descriptive notes on the fossils by W. D. Walcott.

Miller and Knight[2] discuss the metallogenetic epochs of Ontario. Most of the metal production comes from Keweenawan rocks and consists chiefly of silver, nickel, and copper in the order named. Next in importance are the Algoman gold-bearing granite intrusions which have been productive at Porcupine and many other places. The Keewatin has furnished a small tonnage of iron ore.

[1] A. C. Lawson, "The Geology of Steeprock Lake, Ontario," *Canada Dept. of Mines, Mem. No. 28* (1912), 23 pp., 2 pls.

[2] W. G. Miller and C. W. Knight, "Metallogenetic Epochs in the Pre-Cambrian of Ontario," *Ontario Bur. Mines, Ann. Rept.*, Vol. XXIV (1915), Part I, pp. 244–48, map; *Roy. Soc. Canada Trans.*, 3d Ser., Vol. IX (December, 1915), Section IV, pp. 241–49, 1 fig. (map).

Erosion has destroyed much ore. Some ore has been preserved by folding and faulting.

Miller and Knight's[1] classification of the pre-Cambrian of Ontario follows.

Keweenawan
Unconformity
Animikean
Includes rocks called Animikie heretofore, also Logan's type section, and the Cobalt and Ramsay Lake series. Minor unconformities occur within the Animikean
Great unconformity
(Algoman granite and gneiss
Igneous contact)
Laurentian of some authors, the Lorrain granite of Cobalt, and the Killarney granite of Lake Huron
Timiskamian
Includes sedimentaries of various localities heretofore called Huronian—also the Sudbury series of Coleman
Great unconformity
Same order as that at base of Animikie
(Laurentian granite and gneiss)
Igneous contact
Loganian { Grenville (sedimentary) / Keewatin (igneous)

The authors differ from Collins and Coleman in that the latter recognize a twofold division of the Animikean group. Other differences are largely a matter of names and emphasis on the relative importance of various features. Lawson, Coleman, and Collins emphasize the unconformity at the base of the Animikean and recognize two major groups. Miller and Knight stand alone in concluding that the Grenville of southeastern Ontario is in part interlayered, but largely above the Keewatin. Other authors are either less confident or express doubt as to the position of the Grenville.

Parsons[2] describes the productive iron deposits of the Michipicoten district.

[1] W. G. Miller and C. W. Knight, "Revision of Pre-Cambrian Classification in Ontario", *Jour. Geol.*, Vol. XXIII (1915), pp. 585–99.

[2] A. L. Parsons, "The Productive Area of the Michipicoten Iron Ranges (Ontario)," *Ontario Bur. Mines. Ann. Rept.*, Vol. XXIV (1915), Part I, pp. 185–213, 22 figs., 3 pls., maps.

Quirke[1] maps the Española area representing the eastward extension of the original Huronian. His classification of the pre-Cambrian follows.

Great unconformity	
Huronian	
Keweenawan—Diabase injection	
Igneous contact	
Cobalt series	
Gowganda formation—Massive slate	
Conglomerate member	400 feet
Graywacke slate	400 feet
Bedded conglomerate	650 feet
Unconformity	
Bruce series	
Serpent quartzite	8,000 (?) feet
Española group	
Española limestone	25 feet
Española graywacke	280 feet
Bruce limestone	150 feet
Slight unconformity	
Mississagi quartzite	4000 feet
Great unconformity	
Pre-Huronian	
Granite intrusions	
Igneous contact	
Basic intrusions	
Igneous contact	
Schistified sediments	

Large-scale maps were made by Stansfield[2] of certain mica, apatite deposits in the townships of Hull and Buckingham of Ottawa Valley. The pre-Cambrian rocks underlying this area comprise:

Igneous intrusives
- *c*) Trap dykes
- *b*) Gabbro and pegmatites of the mineral deposits
- *a*) Older pegmatite veins

Grenville series
Ottawa gneiss

The Ottawa gneiss includes granite and syenite gneiss, crystalline limestones, quartzites, garnet-gneisses, sillimanite gneisses,

[1] Terence T. Quirke, "Española District, Ontario," *Canada Geol. Surv. Mem. No. 102* (1917), 75 pp. 6 pls., 8 figs., map.

[2] John Stansfield, "Certain Mica, Graphite, and Apatite Deposits of the Ottawa Valley," etc., *Canada Geol. Surv. Summ. Rept. 1911* (1912), pp. 280–85.

and certain unidentified gneisses have been listed as the constituents of the Grenville series in this area.

The Cobalt series[1] comprises a basal conglomerate, resting on a nearly level surface and an assemblage of arkose, quartzite, graywacke, and argillite. Gradations are found in both vertical and horizontal directions. The finer-grained bedded varieties are assigned to a lacustrine origin. The heterogeneous, angular conglomerates with "soled," and occasionally striated pebbles are believed to be glacial.

The Larder Lake[2] district located on the boundary between Ontario and Quebec, about thirty miles north of Lake Timiskaming shows the following succession of rocks, according to Morley E. Wilson:

Pleistocene and recent
- Gravel, sand, clay, and till

Huronian
- Conglomerate
- Graywacke
- Arkose
- Conglomerate

Igneous contact
- Diabase, gabbro, syenite porphyry; the first two probably time equivalents of similar rocks in the Cobalt district

Laurentian
- Granite, gneiss, granodiorite, pegmatite, aplite

Unconformity

Keewatin—Greenstones and greenstone schists largely of effusive origin, Larder slate and dolomite quartz porphyry, rhyolite and aplite intrusive into the preceding

Pontiac schists composed of biotite and quartz. Relation to Keewatin unknown

Igneous contact

Wilson[3] argues against widespread correlations of pre-Cambrian rocks and urges that for the present local names should be given to series and formations.

[1] Morley E. Wilson, "The Cobalt Series: Its Character and Origin," *Jour. Geol.*, Vol. XXI (February–March, 1913), pp. 121–41, 3 figs.

[2] Morley E. Wilson, "Geology and Economic Resources, Larder Lake District, Ontario," *Canada Geol. Surv. Mem. No. 17* (1912), 62 pp., 11 pls., 5 figs., 2 maps.

[3] Morley E. Wilson, "Sub-Provincial Limitations of Pre-Cambrian Nomenclature in the Saint Lawrence Basin" (Abstract), *Bull. Geol. Soc. Am.*, Vol. XXIX (1918), pp. 90–91.

[*To be continued*]